

**Long-Term Variable Milfoil Management and Control Plan for
ALTON BAY TOWN BEACHES- LAKE WINNIPESAUKEE
Alton, New Hampshire
Belknap County**

Prepared by: New Hampshire Department of Environmental Services (DES),
in consultation with the
New Hampshire Fish and Game Department (F&G)
March 2007

PROBLEM STATEMENT

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of lakes and ponds (Luken & Thieret, 1997, Halstead, 2000). According to the 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology (CALM), “exotic macrophytes are non-native, fast growing aquatic plants, which can quickly dominate and choke out native aquatic plant growth in the surface water. Such infestations are in violation of Env-Ws 1703.19, which states that surface waters shall support and maintain a balanced, integrated and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region” (DES, 2006).

Though exotic aquatic plants can negatively impact an aquatic system, native aquatic plants are beneficial to the aquatic ecology of waterbodies. Diverse assemblages of native aquatic plants are a source of oxygen to the system, they provide stabilizing root systems to minimize erosion and turbidity, and they provide food and habitat for aquatic life.

Variable milfoil became established in Alton Bay of Lake Winnepesaukee in the late 1960s. It is currently found in dense patches around most of the shoreline areas of the cove. Figure 1 illustrates the area of variable milfoil infestation in Alton Bay. The Town of Alton is only seeking to manage the variable milfoil to clean up public bathing beach access sites, and we are therefore not examining the entirety of the variable milfoil infestation in Alton Bay (nor are other individual entities, at this time, seeking to manage variable milfoil in Alton Bay). Following is a summary of each area indicated in Figure 1:

Area 1- This is a town beach on the western shoreline of Alton Bay. The infested area is approximately ½ acre, and the milfoil covers roughly 15% of the bottom in this area where water is 5 feet deep or less.

Area 2- This area is another town beach, located on the eastern shore of Alton Bay. The infested area is approximately 1.5 acres, and the milfoil covers 75% of this overall area, where water is 8 feet deep or less.

In terms of the impacts of the variable milfoil in the system, the two locations of Alton Bay that are examined within this management plan are owned by the Town of Alton, and they are used as public bathing beaches on the bay. Milfoil infestations are close to shore in shallow water, and are posing swimming risks due to entanglement and degraded water quality as a result of

dense variable milfoil growths. There are no private houses immediately abutting the lengths of shoreline encompassed within this project.

At this time, there are no data and no observable problems with the biological integrity of the aquatic community as a result of the variable milfoil infestation; however, no biological integrity surveys have been conducted as part of this plan preparation.

PURPOSE

In September 2006, the Town of Alton requested matching funds from the Department of Environmental Services to conduct an aquatic plant control project during the spring of 2007 to control areas infested with variable milfoil.

The purposes of this exotic aquatic plant management and control plan are:

1. To identify the waterbody's beneficial use areas, including essential aquatic habitat, designated conservation zones, swimming areas, boat access sites, and boating use areas;
2. To present the aquatic macrophyte distribution map, including both native and exotic species;
3. To identify short-term and long-term exotic aquatic plant control goals that protect and conserve the lake's beneficial uses;
4. To recommend exotic plant control actions that meet the goals outlined in this plan; and
5. To recommend monitoring strategies to determine the success of the control practices over time in meeting the goals.

This plan also summarizes the current physical, biological, ecological, and chemical components of Alton Bay and the social and ecological impacts of the milfoil infestation.

The intent of this strategic plan is to control variable milfoil in Alton Bay over time through the use of Integrated Pest Management Strategies (IPM). Appendix A details the strategies available for waterbodies with exotic species, and provides more information on each of the activities that are recommended within this plan.

GOALS/OBJECTIVES OF MILFOIL CONTROL ACTIONS

Because of the expansive size of the overall variable milfoil infestation within Lake Winnepesaukee, DES recognizes that eradication of variable milfoil in the lake system as a whole is unlikely, both due to the degree of fragmentation of the plants and subsequent spread, but also due to the overall cost of attempting a lake-wide eradication project on this lake.

For Alton Bay, DES proposes to work with the the Town of Alton to perform variable milfoil management practices to minimize the recreational, ecological, human health, business, and aesthetic impacts caused by dense growths of this invasive plant, while maintaining the overall integrity of native plant communities whenever variable milfoil control actions are being implemented.

Specifically, the goals are as follows:

- 1) In 2007, reduce the overall percent of milfoil bottom growth in Area 1 from ½ acres and 15% cover to 0% variable milfoil in this beach area with the use of 2,4-D and hand pulling. This will allow for smaller scale control actions to take place in future years, including diver removal and benthic barrier placement to control smaller areas of regrowth, to keep variable milfoil at lower levels in the cove.
- 2) In 2007, reduce the overall percent of milfoil bottom growth in Area 2 from 1.5 acres and 75% cover to less than ½ acre and 10% cover with the use of 2,4-D and hand pulling. This will allow for smaller scale control actions to take place in future years, including diver removal and benthic barrier placement to control smaller areas of regrowth, to keep variable milfoil at lower levels in the cove.
- 3) The longer term goal is to maintain variable milfoil coverage at or below 10% of the surface area by using hand-removal, benthic barriers, and/or diver-assisted suction harvesting in summer 2007, and annually thereafter if new stems or localized patches are present. Additional herbicide applications may be done at 3-year intervals if needed to maintain the 10% (or less) level of growth.

Town Support

The Town of Alton recreation department is taking the lead both financially and actively for this project.

WATERBODY CHARACTERISTICS

Table 1 summarizes basic physical and biological characteristics of Alton Bay.

General Lake Information	
Area of Alton Bay (acres)	1360
Shoreline Uses (residential, forested, agriculture)	Residential, marina, beaches, some forested
Max Depth (m)	45
Trophic Status	Oligotrophic
Color (CPU) in Epilimnion	9
Clarity (m)	11
Plant Community Information Relative to Management	
Invasive Plants (Latin name)	<i>Myriophyllum heterophyllum</i>
Infested Area (acres)	2
Distribution (ringing lake, patchy growth, etc)	Locally abundant at beach areas.
Sediment type in infested area (sand/silt/organic/rock)	Sandy, rocky
Rare, Threatened, or Endangered Species in Waterbody (according to NH Natural Heritage Inventory)	Common Loon (<i>Gavia immer</i>) Threatened in NH Purple Martin (<i>Progne subis</i>) Endangered in NH

Figure 2 shows a map of the aquatic plant communities at the two beaches.

BENEFICIAL (DESIGNATED) USES

In New Hampshire, beneficial (designated) uses of our waterbodies are categorized into five general areas: Aquatic Life, Fish Consumption, Recreation, Drinking Water Supply, and Wildlife (CALM).

Of these, Aquatic Life and Recreation are the two affected by the presence of exotic species like variable milfoil.

AQUATIC LIFE

The goal for aquatic life support is to provide suitable chemical and physical conditions for supporting a balanced, integrated and adaptive community of aquatic organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of the region.

FISHERIES AND WILDLIFE

The principal fisheries of Lake Winnepesaukee include both warm and coldwater species. Coldwater species of primary interest are; landlocked Atlantic salmon, lake trout, and rainbow trout; coldwater species of less interest are lake whitefish, round whitefish (species of concern in Wildlife Action Plan), burbot, brook trout, and rainbow smelt.

Warmwater species of primary interest are; largemouth bass, smallmouth bass, white perch, yellow perch, chain pickerel, black crappie, brown bullhead, and bluegill. The bass fishery is extremely popular with anglers as numerous fishing tournaments are held on the lake each year.

Numerous warmwater species are present in littoral areas of the lake and constitute the prey fish sought by larger gamefish (warmwater). These species include; banded killifish, common shiner, common white sucker, creek chubsucker, bridled shiner (species of concern in Wildlife Action Plan), fallfish, golden shiner, pumpkinseed, redbreast sunfish, rock bass, slimy sculpin, and yellow bullhead.

The American eel, a catadromous species, reside up to 4-9 years in our inland lakes, such as Lake Winnepesaukee, where they reach sexual maturity and migrate down the rivers and outlets of our large lakes to the Atlantic Ocean.

RECREATIONAL USES AND ACCESS POINTS

Alton Bay is used for numerous recreational activities, including boating, fishing, swimming, and water skiing by both lake residents and transient boaters. Additionally, on Alton Bay there are places of business, including marinas, restaurants, and other shops. Figure 3 illustrates key elements of the pond and watershed that may be of interest in this evaluation. There is a public access site on the western side of the lake, and access can also be achieved at area marinas.

The two public beaches on Alton Bay are of interest for this exotic aquatic plant control project. The town of Alton has specifically requested assistance in managing milfoil in these two specific locations.

There is not a lot of transient boating, or visiting boats, within Alton Bay.

There are two public (“designated”) swim areas within Alton Bay. A designated beach is described in the CALM as an area on a waterbody that is operated for bathing, swimming, or other primary water contact by any municipality, governmental subdivision, public or private corporation, partnership, association, or educational institution, open to the public, members, guests, or students whether on a fee or free basis. Env-Wq 1102.14 further defines a designated beach as *“a public bathing place that comprises an area on a water body and associated buildings and equipment, intended or used for bathing, swimming, or other primary water contact purposes. The term includes, but is not limited to, beaches or other swimming areas at hotels, motels, health facilities, water parks, condominium complexes, apartment complexes, youth recreation camps, public parks, and recreational campgrounds or camping parks as defined in RSA 216-I:1, VII. The term does not include any area on a water body which serves 3 or fewer living units and which is used only by the residents of the living units and their guests.”*

MACROPHYTE EVALUATION

The littoral zone is defined as the nearshore areas of a waterbody where sunlight penetrates to the bottom sediments. The littoral zone is typically the zone of rooted macrophyte growth in a waterbody. The littoral zone of the bay is characterized by a mix of native and non-native (variable milfoil) plant growth (Figure 13). Native species include a mix of floating plants (yellow and white water-lilies, floating leaved pondweeds, and water shield), emergent plants (bur-reed, pickerelweed), and submergent plants (bladderwort, pondweed). Native plant communities are mixed around segments of the bay, and are characterized as ‘sparse’ for the bay.

There are no records with the Natural Heritage Bureau of any rare, threatened, or endangered plants in this cove, or in Lake Winnepesaukee.

HISTORICAL CONTROL ACTIVITIES ON ALTON BAY:

The swim beaches have not historically been treated with aquatic herbicides.

MILFOIL MANAGEMENT OPTIONS

The control practices used should be as specific to variable milfoil as feasible.

Exotic aquatic plant management relies on a combination of proven methods that control exotic plant infestations, including physical control, chemical control, biological controls (where they exist), and habitat manipulation. Integrated Pest Management Strategies (IPM) are typically implemented using Best Management Practices (BMPs) based on site-specific conditions so as to maximize the long-term effectiveness of control strategies. Descriptions for the control activities

are closely modeled after those prescribed by the Aquatic Ecosystem Restoration Foundation (AERF) (2004). This publication can be found online at http://www.aquatics.org/aquatic_bmp.pdf.

Criteria for the selection of control techniques are presented in Appendix A. Appendix B includes a summary of the exotic aquatic plant control practices used by the State of New Hampshire. DES has evaluated the feasibility of potential control practices in Alton Bay. The following table summarizes DES' control strategy recommendations for Alton Bay.

FEASIBILITY EVALUATION FOR CONTROL ALTERNATIVES

Control Method	Use on Alton Bay
Restricted Use Areas	Not a reasonable location as these are public bathing beaches owned by the town of Alton. DES does recommend that the town install fragment barriers to keep the swim area clear of milfoil fragments and to prevent (or slow) re-infestation of the swim beach following the herbicide application.
Hand-pulling	DES recommends that the Town of Alton coordinate regular diver activities within the boundaries of the two swim beaches to ward off any re-growth and re-encroachment of milfoil into the swim areas. Once the herbicide thins the milfoil populations, diver removal should be quite feasible.
Mechanical Harvesting/Removal	Mechanical harvesting is not recommended as a management strategy due to the fast re-growth rate of variable milfoil from cut stems.
Benthic Barriers	DES does not recommend widescale placement of benthic barriers in beach areas. Benthic barriers can trap gases released from the sediments, causing bubbling and uplifting of the barrier. This can pose drowning risks to swimmers that visit the beaches.
Herbicides	DES recommends the use of 2,4-D in May or early June 2007 to remove variable milfoil from the vicinity of the two town owned swim beaches on Alton Bay.
Extended Drawdown	Infeasible due to the fact that this is one bay on Lake Winnepesaukee, and the whole lake cannot be lowered enough to control the plant.
Dredge	Cost prohibitive and ecologically damaging.
Biological Control	There are no approved biological controls for variable milfoil at this time in New Hampshire.
No Control	Because these two areas are public swim beaches, and the variable milfoil poses human health risks from entanglement in the plants, and degraded water quality conditions, it is recommended that action be taken to control the variable milfoil at these two beach sites.

EXOTIC AQUATIC PLANT CONTROL PLAN

An evaluation of the size, location, and type of variable milfoil infestation, as well as the waterbody uses was conducted by DES during September 2006. Based on the evaluation, the following control actions are recommended for Alton Bay:

Year	Treatment Type	Responsible Party	Schedule
2007	2,4-D treatment of Alton Bay in Area 1 and Area 2	Lycott Environmental Inc.	May/June
	Train local divers for hand-removal techniques	NH DES, Town of Alton or hired divers	June/July
	Hand-removal of variable milfoil to slow overall regrowth	Town of Alton or hired divers	June/July
	Perform Weed Watcher activities and work together as an association to make sure boats entering and leaving the cove are exotic species free	Town of Alton or hired divers	Monthly during summer months
2008	Hand-removal of variable milfoil to slow overall regrowth	Town of Alton or hired divers	June/July
	Perform Weed Watcher activities and work together as an association to make sure boats entering and leaving the cove are exotic species free	Town of Alton or hired divers	Monthly during summer months
2009	Hand-removal of variable milfoil to slow overall regrowth	Town of Alton or hired divers	June/July
	Perform Weed Watcher activities and work together as an association to make sure boats entering and leaving the cove are exotic species free	Town of Alton or hired divers	Monthly during summer months
	Site assessment and remap of area to determine need for 2010 herbicide application	DES	August/September
2010	1. Perform 2,4-D treatment if needed (as determined by DES Limnologists)	Licensed Contractor	June-August
	Hand-removal of variable milfoil to slow overall regrowth	Town of Alton or hired divers	June/July
	Perform Weed Watcher activities and work together as an association to make sure boats entering and leaving the cove are exotic species free	Town of Alton or hired divers	Monthly during summer months

Year	Treatment Type	Responsible Party	Schedule
2011	Hand-removal of variable milfoil to slow overall regrowth	Town of Alton or hired divers	June/July
	Perform Weed Watcher activities and work together as an association to make sure boats entering and leaving the cove are exotic species free	Town of Alton or hired divers	Monthly during summer months
2012	Update and revise Long-Term Variable Milfoil Control Plan	NH DES, F&G, and interested parties	Spring 2012

CONSIDERATIONS FOR SELECTED MANAGEMENT PRACTICE

- Approximately 2.02 acres of this 1,360 acre bay will be treated with aquatic herbicide (<1%). The town has committed to performing hand-removal or benthic barrier placement as needed to prevent or slow re-growth.
- The Department of Agriculture will impose standard short-term use restrictions for specified days depending on the waterbody uses (irrigation, contact, etc) and the herbicide label. The shoreline will be posted and public notice will be made.
- By recommending follow-up management practices annually after the herbicide application, we will employ an integrated plant management approach such as benthic barrier placement and hand-pulling re-growth, so that variable milfoil re-growth or population expansion can be slowed. The ultimate goal of this project is to reduce variable milfoil growth to maintain the designated uses of the cove.

Figure 1- Map of Variable Milfoil Infestation

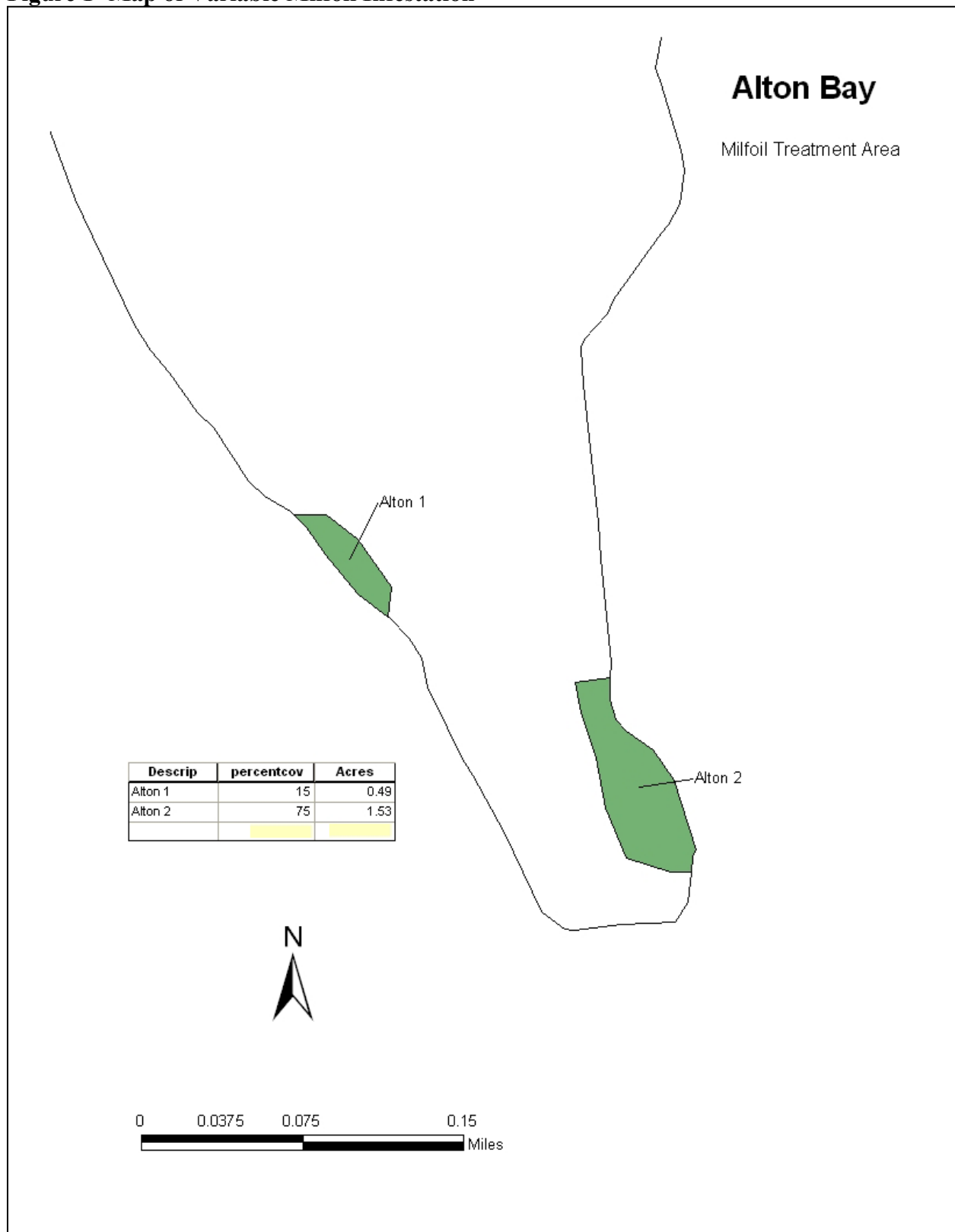
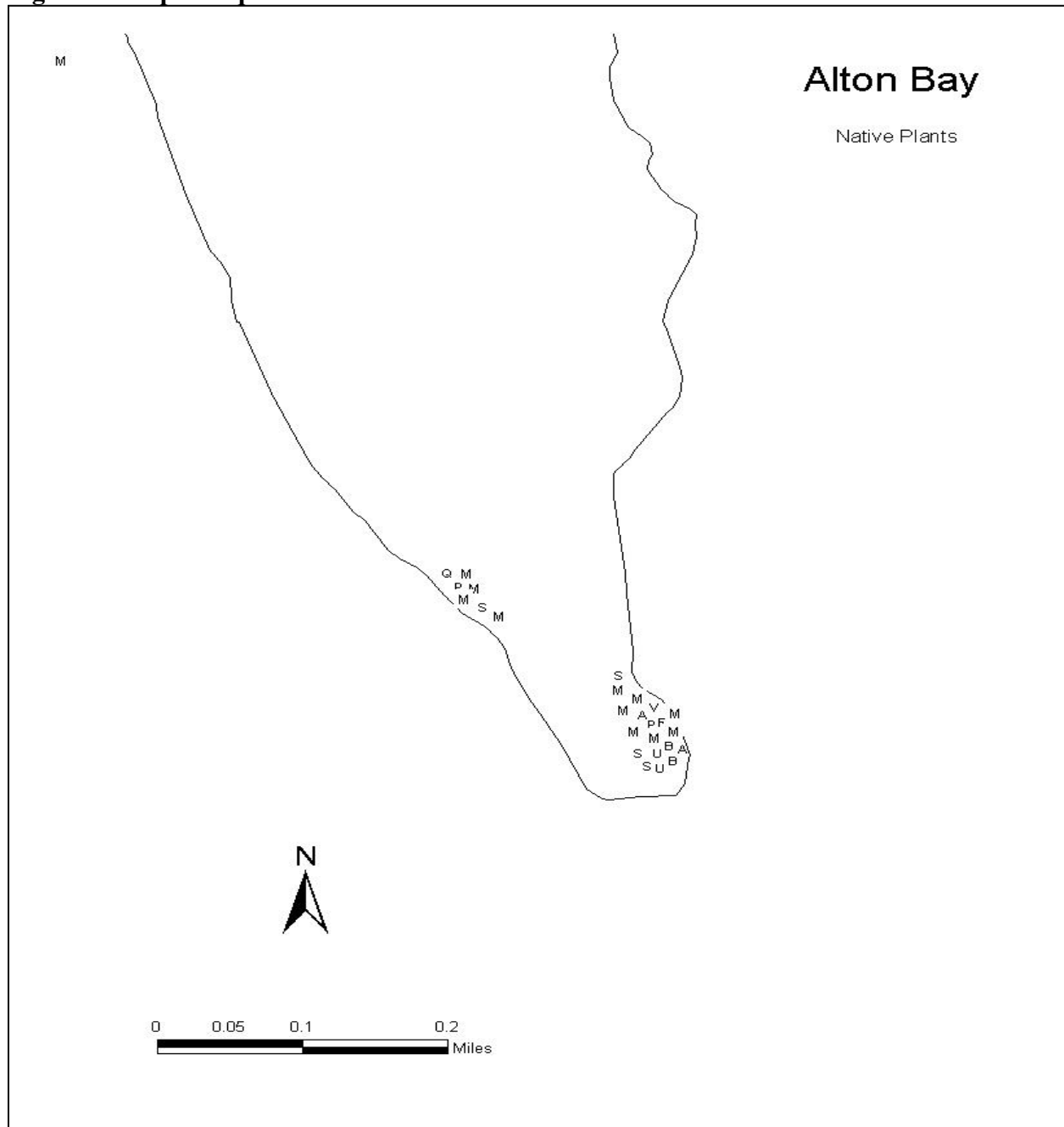
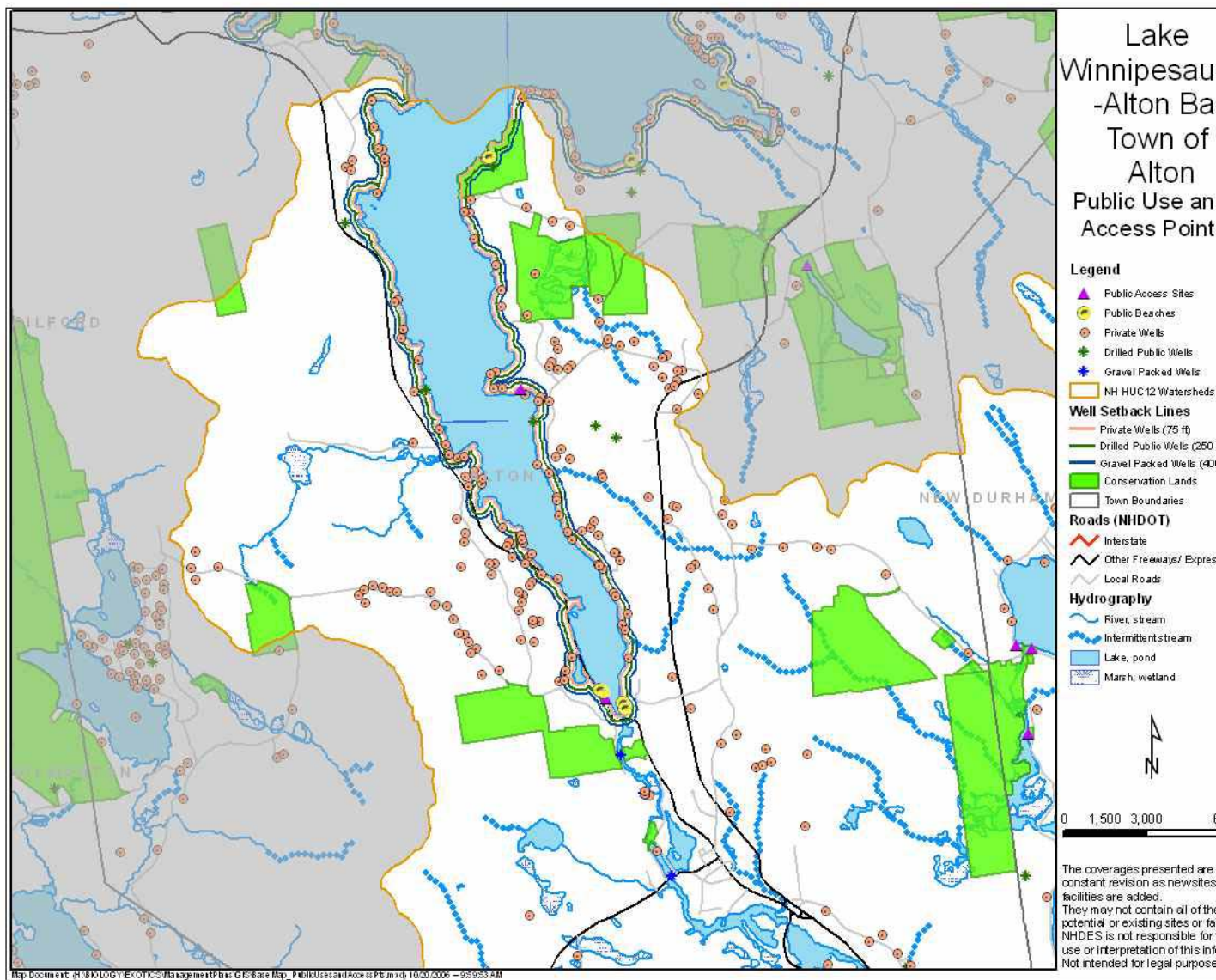


Figure 2- Map of Aquatic Plants



Symbol	Common Name	Latin Name
V	Tapegrass	<i>Vallisneria</i>
S	Bur-reed	<i>Sparganium</i>
B	Watershield	<i>Brasenia</i>
A	Bassweed	<i>Potamogeton amplifolius</i>
R	Robbin's pondweed	<i>Potamogeton robbinsii</i>
U	Bladderwort	<i>Utricularia</i>
P	Pondweed spp	<i>Potamogeton spp.</i>
Q	Quillwort	<i>Isoetes</i>
M	Variable milfoil	<i>Myriophyllum heterophyllum</i>

Figure 3- Public and Private Access Points



APPENDIX A

Criteria to Evaluate the Selection of Aquatic Plant Control Techniques

NH Department of Environmental Services

Water Division

Preliminary Investigations

I. Field Site Inspection

- Verify genus and species of the plant.
- Determine if the plant is a native or exotic species per RSA 487:16, II.
- Map extent of the plant infestation (area, water depth, height of the plant, density of the population).
- Document any native plant abundances and community structure around and dispersed within the exotic/nuisance plant population.

II. Office/Laboratory Research of Waterbody Characteristics

- Contact the appropriate agencies to determine the presence of rare or endangered species in the waterbody or its prime wetlands.
- Determine the basic relevant limnological characteristics of the waterbody (size, bathymetry, flushing rate, nutrient levels, trophic status, and type and extent of adjacent wetlands).
- Determine the potential impacts to downstream waterbodies based on limnological characteristics (water chemistry, quantity, quality).

Overall Control Options

For any given waterbody that has an infestation of exotic plants, one of three options will be selected, based on the status of the infestation, the available management options, and the technical knowledge of the DES Limnologists who have conducted the field work and who are preparing this plan. The options are as follows:

- 1) **Eradication:** Herbicide application targeted at exotic aquatic plant to be eradicated, to either eradicate the plant or to reduce overall biomass to a point where alternative non-chemical strategies may be used. This action will be followed by thorough annual monitoring for regrowth and the use of non-chemical actions to achieve the eradication.
- 2) **Containment:** The aim of this approach is to limit the size and extent of the existing infestation. An herbicide application may be used to reduce specified areas down to a percent cover of the exotic species so that it can be maintain or contained with alternative management strategies, including Restricted Use Areas, benthic barriers, and others. Subsequent herbicide applications may be necessary if the target species shows exponential growth and further spread.

- 3) No action. If the infestation is too large, spreading too quickly, and past management strategies have proven ineffective at controlling the target exotic aquatic plant, DES, in consultation with others, may elect to recommend 'no action' at a particular site. All efforts will instead be made towards containment of the target species to that specific waterbody, so that downstream migration of the plant can be prevented.

If eradication or control is the recommended option to pursue, the following series of control techniques may be employed. The most appropriate technique based on the determinations of the preliminary investigation will be selected.

Guidelines and requirements of each control practice are detailed below each alternative.

A. Hand-Pulling

- Can be used for exotic or native species.
- Can be used if infestation is in a small localized area (sparsely populated patch of up to 5' X 5', single stems, or dense small patch up to 2' X 2').
- Can be used if plant density is low, or if target plant is scattered and not dense.
- Can be used if the plant could effectively be managed or eradicated by hand-pulling a few scattered plants.
- Use must be in compliance with the Wetlands Bureau rules.

B. Mechanically Harvest or Hydro-Rake

- Can not be used on plants which reproduce vegetatively by fragmentation (e.g., milfoil, fanwort, etc.) unless containment can be ensured.
- Can be used only if the waterbody is accessible to machinery.
- Can be used if there is a disposal location available for harvested plant materials.
- Can be used if plant depth is conducive to harvesting capabilities (~ <7 ft. for mower, ~ <12 ft. for hydro-rake).
- Funds are available for repeated harvesting activities in that season.
- A navigation channel is required through dense plant growth.

C. Chemical Treatment

- Can be used if application of chemical is conducted in areas where alternative control techniques are not optimum due to depth, current, use, or type of plant.
- Can be used for treatment of exotic plants where fragmentation is a high concern.
- Can be used where species specific treatment is necessary due to the need to manage other plants (rare or endangered that will not be impacted by chemical treatment).
- Can be used if other methods used as first choices in the past have not been effective.
- A licensed applicator should be contacted to inspect the site and make recommendations about the effectiveness of chemical treatment as compared with

other treatments.

D. Restricted Use Areas (per RSA 487:17, II (d))

- Can be used for exotic species only.
- Can be established in an area that effectively restricts use to a small cove, bay, or other such area where navigation, fishing, and other activities may cause fragmentation to occur.
- Can not be used when there are several “patches” of an infestation of exotic aquatic plants throughout a waterbody.
- Can be used as a temporary means of control.

E. Bottom Barrier

- Can be used for exotic or native species.
- Can be used in small areas, preferably less than 10,000 sq. ft.
- Can be used in an area where the current is not likely to cause the displacement of the barrier.
- Can be used early in the season before the plant reaches the surface of the water.
- Can be used in an area to compress plants to allow for clear passage of boat traffic.
- Can be used in an area to compress plants to allow for a clear swimming area.

F. Drawdown

- Can be used if the target plant(s) are susceptible to drawdown control.
- Can be used in an area where bathymetry of the waterbody would be conducive to an adequate level of drawdown to control plant growth, but where extensive deep habits exist for the maintenance of aquatic life such as fish and amphibians.
- Can be used where plants are growing exclusively in shallow waters where a drawdown would leave this area “in the dry” for a suitable period of time (over winter months) to control plant growth.
- Can be used in winter months to avoid encroachment of terrestrial plants into the aquatic system.
- Can be used if it will not significantly impact adjacent or downstream wetland habitats.
- Can be used if spring recharge is sufficient to refill the lake in the spring.
- Can be used in an area where shallow wells would not be significantly impacted.
- Reference RSA211:11 with regards to drawdown statutes.

G. Dredge

- Can be used in conjunction with a scheduled drawdown.
- Can be used if a drawdown is not scheduled, though a hydraulic pumping dredge should be used.

- Can only be used as a last alternative due to the detrimental impacts to environmental and aesthetic values of the waterbody.

H. Biological Control

- Grass carp cannot be used.
- Exotic controls, such as insects, cannot be introduced to control a nuisance plant.
- Research should be conducted on a potential biological control prior to use to determine the extent of host specificity.

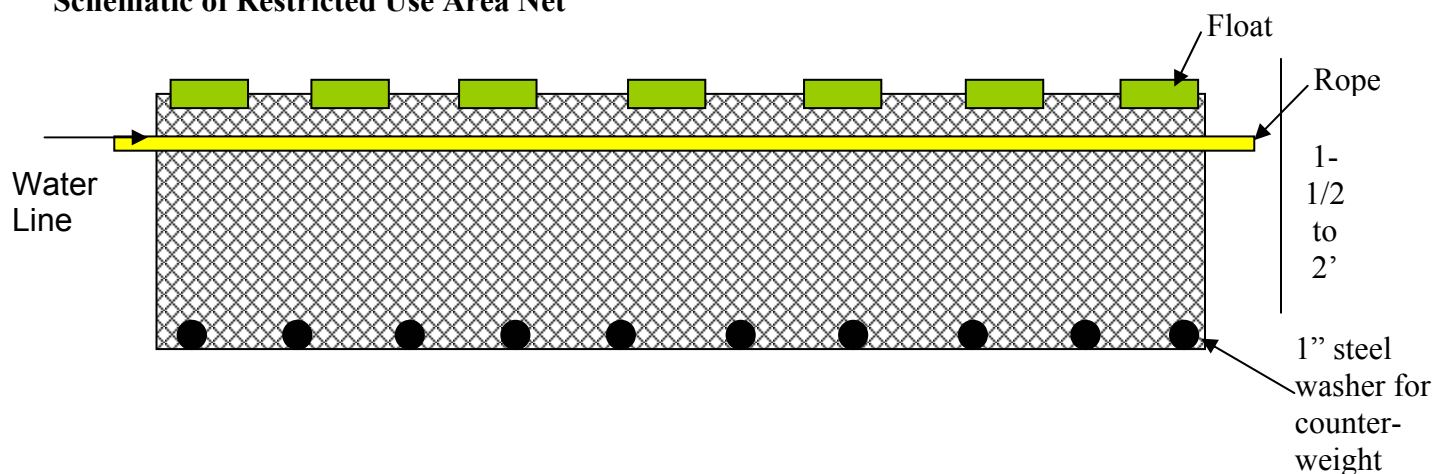
APPENDIX B

SUMMARY OF CONTROL PRACTICES USED IN THE STATE OF NEW HAMPSHIRE FOR EXOTIC AQUATIC PLANTS

Restricted Use Areas:

Restricted Use Areas (RUAs) are a regular control option for lakes with small, contained infestations of exotic plants, limited to small patches or embayments. This is often the case in waterbodies with newly-discovered infestations. RUAs restrict access to all recreational activities in a delineated area to minimize plant fragmentation and thereby reduce the spread of milfoil. As an additional method of protection from fragment migration, RUAs are encircled with a shallow net that is suspended vertically in the water column. The net is approximately 1.5-2.0 feet in height. The top of the net is set to extend four inches above the surface of the water, while the remainder is positioned below the surface of the water (see figure below). This configuration prevents the movement of fragments from infested areas to uninfested areas. Due to the size and nature of net construction, there is no impediment to fish migratory patterns or spawning activities.

Schematic of Restricted Use Area Net



Hand-pulling:

When infestations of exotic aquatic plants begin as single scattered stems or small patches, DES biologists SCUBA dive to hand-pull the plants (and DES can train other certified divers to also perform this management practice). Guidelines for determining feasibility and effective for hand-removal are site specific, but generally sparsely populated patches of up to 5' X 5', single stems, or dense small patch up to 2' X 2' are reasonable.

The whole plant including the roots should be removed in this process, while leaving the beneficial native species intact. This technique works best in softer sediments, with shallow rooted species and for smaller, scattered infestation areas. When hand pulling nuisance species, the entire root system and all fragments of the plants must be collected since small root or stem fragments could result in additional growth of the species. The process must be repeated often to control re-growth of the exotic plants. For a new infestation, hand-pulling activities are typically conducted several times during the first season, with follow-up inspections for the next 2-5 years

or until no re-growth is observed. This control practice has proven successful in many waterbodies.

Mechanical Harvesting

The process of mechanical harvesting is conducted by using machines which cut and collect aquatic plants. These machines can cut the plants up to twelve feet below the water surface. The weeds are cut and then collected by the harvester or other separate conveyer-belt driven device where they are stored in the harvester or barge, and then transferred to an upland site.

The advantages of this type of weed control are that cutting and harvesting immediately opens an area such as boat lanes, and it removes the upper portion of the plants. Due to the size of the equipment, mechanical harvesting is limited to water areas of sufficient size and depth. It is important to remember that mechanical harvesting can leave plant fragments in the water, which if not collected, may spread the plant to new areas. Additionally harvesters may impact fish and insect populations in the area by removing them in harvested material. Cutting plant stems too close to the bottom can result in re-suspension of bottom sediments and nutrients. This management option is only recommended when nearly the entire waterbody is infested, and harvesting is needed to open navigation channels through the infested areas.

Benthic Barriers:

When a small infestation of exotic aquatic plants occurs in clusters of growth (generally areas $>5 \text{ ft}^2$), as opposed to scattered stems, a permeable fiberglass screen can be placed over the area of infested lake sediments. The permeable fabric screening allows for gas release from the sediments while effectively blocking sunlight and compressing the plants into the sediment, inhibiting photosynthesis and eventually killing the plant. Occasionally, in some lakes, gas release from the sediments or boating activity cause the uplifting of screening. Benthic barriers can effectively control small infestations of less than approximately 10,000 square feet.

Benthic barriers have two basic applications. These practices are used to cover pioneering infestations and prevent the spread of the plant. Bottom barriers are installed across small portions of lake bottoms infested with invasive aquatic plants. The disadvantage of benthic barriers is their non-selectivity and limitation of cover to less than 10,000 square feet. Additionally, these physical barriers prevent the growth of all vegetation, which is a necessary component of fish and wildlife habitat.

Bottom barriers are attached to the bottom of a water body by re-bar attached to the edges and across the middle of the material. Bottom barriers are transported to the shoreline adjacent to where installation is to occur. They are then cut to fit the treatment site and rolled onto a length of pipe. Divers carry the roll into the water at the start of the treatment site and secure one edge of the material to the lake bottom. The divers then roll out the remainder of the material and continue to secure it to the bottom sediments. This process is repeated until the plants in the treatment are covered.

Bottom barriers are generally considered for small localized areas rather than lakewide application. Bottom barriers provide 100% control of this weed in areas where they are installed. They also provide long-term control. An ongoing maintenance operation is required to inspect the bottom barrier and clear the mats of sediment buildup.

Benthic barriers are not recommended for application in river systems, as flow can easily uplift the barrier.

Targeted Application of Herbicides:

The use of chemicals, such as herbicides, for the control of noxious and nuisance plant species represents one of the most widely known and effective management options available. Herbicide control of invasive aquatic plants is often the first step in a long-term integrated control program. In the last 15 to 20 years the use and review of herbicides has changed significantly in order to accommodate safety, health, and environmental concerns. Currently no herbicide product can be labeled for aquatic use if it has more than a one in a million chance of causing significant harmful effects to human health, wildlife, or the environment. Because of this, the number of effective and U.S. Environmental Protection Agency (EPA) approved herbicides for aquatic weeds are limited. In most cases the cost and time of testing and registration, rather than environmental issues, limits the number of potentially effective compounds.

All herbicide applications in New Hampshire are performed under permits issued by the New Hampshire Department of Agriculture, Division of Markets and Food, Bureau of Pesticide Control.

Two herbicides have been used in New Hampshire for the control of milfoil. Diquat (trade name Reward), the most often-used herbicide, is a contact herbicide that can generally provide one season of control for milfoil. Because this herbicide does not target the root systems, the plants eventually re-grow from established roots.

The second herbicide, 2, 4-D (trade name Navigate or Aqua Kleen), is a systemic herbicide. It is absorbed into the sediments and taken up through the root system, killing both the roots and the plant biomass above the sediments. Label restrictions for aquatic application currently limit its use in New Hampshire to waterbodies with no water intakes, and with no wells adjacent to the shoreline.

The aquatic herbicide SONAR has been used in New Hampshire to control growths of fanwort. The chemical acts by limiting photosynthesis when chlorophyll-a is affected by the active ingredient of the herbicide.

Extended Drawdown

Water drawdown is used for control of some species of aquatic macrophytes. Drawdown requires some type of mechanism to lower water levels, such as dams or water control structures and use is thus limited. It is most effective when the drawdown depth exceeds the depth or invasion level of the target plant species.

In northern areas, drawdown will result in plant and root freezing during the winter for an added degree of control. Drawdown is typically inexpensive and has intermediate effects (2 or more years). However, drawdown can have other environmental effects and interfere with other functions of the water body (e.g. drinking water, recreation, or aesthetics). Drawdown can result in the rapid spread of highly opportunistic annual weed species, which in most cases is the plant that is targeted for control.

Drawdowns have been used in the past for plant control. In theory, the drying of the plants in the summer, or the freezing of the plants in the winter, will eliminate or limit plant growth. However, milfoil often forms a more succulent terrestrial form during drawdown conditions and the succulent form of the plant can remain viable for long periods of time without submergence, making the practice ineffective. This strategy can be used for control of some native plant species.

Dredging

Dredging is a means of physical removal of aquatic plants from the bottom sediments using a floating or land-based dredge. Dredging can create a variety of depth gradients creating multiple plant environments allowing for greater diversity in lakes plant, fish, and wildlife communities. However due to the cost, potential environmental effects, and the problem of sediment disposal, dredging is rarely used for control of aquatic vegetation alone.

Dredging can take place in to fashion, including drawdown followed by mechanical dredging using an excavator, or using a diver-operated suction dredge while the water level remains up.

Biological Control

There are no approved biological controls for submersed exotic aquatic plant at this time in New Hampshire.

REFERENCES

Department of Environmental Services. 2006: 2006 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology. November 2005. New Hampshire Department of Environmental Services. NHDES-R-WD-05-29. Available at <http://des.nh.gov/WMB/swqa/calm.html>

Halstead, J.M., J. Michaud, S. Hallas-Burt, and J.P. Gibbs. 2003. "An Hedonic Analysis of Effects of a Nonative Invader (*Myriophyllum heterophyllum*) on New Hampshire (USA) Lakefront Properties." *Environmental Management*. 32 (3): 391 – 398

Luken, J.O. and J.W. Thieret. 1997. *Assessment and Management of Plant Invasions*. Springer-Verlag, New York. 324 pages.